ecclesiastical

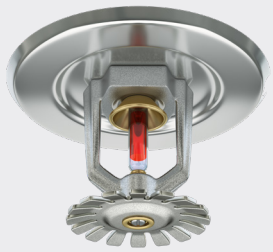
White Paper

Avoiding Freeze-Ups & Malfunctions of Automatic Fire Sprinkler Systems

Introduction

An automatic fire sprinkler system is one of the most important safety features in a building. By controlling a fire in its earliest stages, a sprinkler system can limit the spread of damage to a relatively small area, minimize disruption to operations and, most importantly, save lives. Moreover, sprinklers cause much less water damage than do fire department hoses.

In Canada, both National and Provincial fire codes require sprinklers to be installed in many types of new buildings, as well as buildings that are being repurposed and / or undergoing major renovations. A number of provinces also require older buildings to be retrofitted with fire sprinkler systems — for example, buildings that are used as schools and long term care facilities.[1]



A typical automatic sprinkler head

To ensure optimal performance, sprinkler systems must be properly installed and regularly maintained. A defective or impaired system can fail during a fire; it can also cause substantial water damage by leaking unexpectedly when there is no fire. When sprinkler systems become damaged or impaired, it is most often due to inadequate maintenance and testing.

Some knowledge of automatic sprinkler system design along with a formal testing and maintenance plan will help ensure that a system performs as intended and does not become a liability.

Myth
When a fire occurs every sprinkler goes off.

Fact
Sprinklers are individually activated by heat. Residential fires are usually controlled with one operating sprinkler. Ninety percent of all commercial fires are controlled with six or fewer sprinklers.

Myth
Automatic sprinkler systems are very costly.

Fact
It is usually far less expensive to install a system than to repair (or replace) the damage caused by fire in an unprotected building.

Sprinkler systems: an overview

The design and installation criteria for sprinkler systems are specified by the National Fire Protection Association (NFPA 13 — Standard for the Installation of Sprinkler Systems).[2] Most non-industrial buildings fall under the Light Hazard Occupancy category and require a fairly straightforward sprinkler system configuration.

The two most common systems are the Wet Pipe and Dry Pipe systems. Both are connected to a water source — generally a municipal water supply with a connection on the building exterior that allows firefighters to introduce more water if required. Water entering the system is regulated by a series of control valves which can be used to shut the system off in order to perform maintenance. For safety reasons, these valves should normally be set to "Open", and locked in that mode, with only designated personnel authorized to close them

Both Wet Pipe and Dry Pipe systems use a grid-work of smaller pipes that covers the ceiling and is connected to the main water source by a riser. Individual sprinkler heads are fitted into this grid-work at predetermined intervals to provide coverage to the entire floor area. Heads can also be placed in areas where fires may start unnoticed, for example in attics and floor and ceiling spaces. The internal pressure of the system and the diameter of the pipe-work are calculated to ensure that there will always be sufficient water at any given head, taking into account the building's size and occupancy.

While there are various sprinkler head designs, most incorporate a small valve that holds back water (in a Wet Pipe system) or compressed air (in a Dry Pipe system). This valve is typically held shut by a glass bulb filled with heat-sensitive liquid, although fusible struts — thin pieces of metal held in place with solder — may also be used. In both cases, the hot gases from a fire cause the valve to open allowing water to escape onto a deflector plate and then onto the fire below. Since heat must be present in order to activate the sprinkler head, no water is released to areas where there is no fire. Sprinkler heads do not activate all at once. They activate as required, one by one. The belief that a small fire will trigger all the sprinkler heads in a building is a common misconception.

Two most common types of automatic sprinkler systems

Wet Pipe Systems

Wet Pipe sprinkler systems in which the pipes are permanently filled with water are the simplest and most often used. The advantage of this system is that there is no significant delay in performance. As soon as the valve on a sprinkler head opens, water escapes immediately. Wet Pipe sprinkler systems are particularly suited to buildings where a fast-acting system may be critical for life safety. Unfortunately, since this system contains standing water, it cannot be used in locations that are subject to freezing temperatures.

Dry Pipe Systems

In Dry Pipe sprinkler systems, the pipe-work is filled with pressurized air instead of water. The air holds the main control valves shut and keeps water from entering the system. When the valve on a sprinkler head opens, the air escapes reducing the pressure inside the system and drawing water into the pipes and then through the open valve on the sprinkler head. The advantage of a Dry Pipe system is that it does not normally contain standing water, making it ideal for use in places where pipes can freeze — for example attics and roofs. The disadvantage is that there is a longer delay before water is released.

Why sprinkler systems fail

Sprinkler systems rarely fail due to manufacturing defects. Based on sprinkler leakage loss reports, the chances of a sprinkler opening accidentally due to a defect have been estimated at less than 1 in 16 million.[3] It is much more likely that a system failure will occur due to improper installation, inadequate maintenance, or preventable physical damage. Consider the following:

- Accidental overheating can activate a sprinkler head. This is commonly caused by installing heads too close to sources of heat — for example heating vents, skylights, lighting fixtures. Contractors engaged in hot work, such as welding, cutting, brazing etc., can also cause accidental discharges.

Discharge might occur if a sprinkler head is accidentally overheated or damaged

- Discharge can occur when a sprinkler head or system pipe is damaged as a result of impact by equipment — ladders, forklifts, goods stored on shelving in close proximity to sprinkler components, etc.
- Corrosion or rust can weaken pipes and sprinkler heads and ultimately cause water release.
- Improper system design and installation can cause a number of problems.
- A sprinkler installation may be damaged during construction or renovation work.
- Pipes that are inadequately insulated can freeze and rupture during the winter months, rendering a sprinkler system inoperable and potentially causing severe damage once temperatures rise and pipes begin to thaw.
- Pipes and sprinkler heads may be targets for vandalism.

Common Problems with Wet Pipe Systems

During extreme cold weather, something as simple as a loose siding panel, an un-caulked window frame, an improperly shut door, or missing / damaged insulation can cause indoor temperatures to fall below the freezing mark and cause sprinkler pipes to freeze.

Most freeze-ups in Wet Pipe systems tend to occur near the perimeters of a building or in spaces that are not readily visible — attics, wall and floor joist areas, etc. Sprinkler pipes running through these areas are more vulnerable than regular plumbing because they are smaller in diameter and the water inside them is completely static.

One of the most common causes of frozen sprinkler pipes is inadequate heating. When normal heating levels are not maintained, for example during extended winter holidays, pipes can quickly freeze-up and break. Since a leak may persist undetected for several days, the damage can be particularly devastating.

Protecting a Wet Pipe System

Conducting a thorough winterization inspection of a facility can help protect a Wet Pipe system from freezing. Winterization should begin in the fall and continue through the season. Maintenance staff should:

- Examine attic and floor voids, basements, building entrances, stair enclosures, wall cavities and plant rooms. Ensure that adequate heat can be maintained or that the pipe work is suitably protected against freezing.
- Make sure that sufficient heat is getting to the spaces in false or drop down ceilings that are installed beneath pipe work.
- Conduct a thorough inspection of the facility for drafts and cold air leaks, not only around door and window frames (re-caulking as necessary) but also through external walls and the roof. Ideally, a detailed energy audit should be conducted by a certified energy audit firm; this is especially important for newly completed buildings or buildings that have undergone major renovations.
- Ensure that doors and windows are shut tightly and checked regularly during periods of sustained cold weather.
- Inspect the visible parts of the sprinkler system every few hours during periods of extreme cold weather, looking for broken or cracked piping and for distorted or leaking sprinkler heads.
- Make sure that the inside temperature — including the main sprinkler control valve room, fire pump room and in any area that may be vacant — is maintained above 4 °C (40 °F). Use temperature gauges in areas where the temperature may dip close to the 4 °C mark, such as stair wells, roof voids and attics. These should be checked daily and, during a severe cold snap, on an hourly basis if possible.
- Make arrangements for heating to be maintained in portions of the building that are vacated for part or all of the winter season.
- Have access to vacated rooms so that appropriate cold weather checks can be carried out.
- Display the emergency contact details of your fire sprinkler maintenance provider in the main sprinkler control valve room and at the main fire panel.
- Make sure that the outdoor Fire Department Siamese connections are free of debris and easily accessible. If there are Fire Department Connections that are not fitted with secure locking caps, ask your sprinkler maintenance company to install them.
- Have the flow switch alarm monitored by a ULC listed alarm monitoring company

Protecting a Wet Pipe System

Dry Pipe systems are designed to function well in unheated areas because, under normal circumstances, they do not contain any water. However, even a Dry Pipe system is vulnerable to freeze-ups as a result of poor system design and maintenance. For example, if there is a break or fracture in the pipe-work, the air pressure can drop causing the main control valve to open and water to flow into the pipes. The water may leak through existing breaks in the pipe-work or it may pool at low points in the system where it can freeze.

Pooling can also occur when pipes are installed at the wrong slope or when water has not been drained from the system after it has been activated, typically following routine testing.

Pressure gauges should be checked regularly for signs of a problem

A Dry system can also activate without triggering a full alarm. Although uncommon, a valve failure may cause the system to fill with water, triggering only an intermittent low pressure signal. This trouble signal should not be overlooked; it could mean that the un-insulated dry lines are filled with water and may be subject to freezing temperatures.

Accumulated condensation can also cause freezing in a Dry Pipe system. If the air compressor is located in a warm and humid area, moisture may be drawn into the system, eventually collecting at low points and freezing.

Check the slope of your piping to ensure that water cannot become trapped in branch lines Pressure gauges should be checked regularly for signs of a problem

Protecting a Dry Pipe System

While Dry Pipe systems can be as vulnerable to freezing as Wet Pipe systems, there are a number of measures that can help ensure their problem-free operation:

- Inspect Dry Pipe systems regularly and have leaks repaired as soon as possible.
- Make sure that your sprinkler maintenance company blows out the sprinkler lines after the annual Full Trip Test so there is no water remaining in the pipe work.
- Where dual valves have been installed at the low points of the system, check them weekly to make sure that the pipe-work is completely free of water.
- Check the slope of the piping and the condition of the pipe hangers each fall to ensure that water cannot become trapped in branch lines.
- Ensure that the main Control Valve set and fire pump are located in an area where heating is maintained. Check regularly to ensure the temperature remains above 4 °C (40 °F).
- Make sure that the air compressor and air intake valve are located in a cool/dry area to prevent moisture from getting into the system.
- Check water supply and system pressure gauge readings daily and record these readings on a regular basis (weekly, at the least).
- Make sure that your system is checked regularly for any air leaks. If there are leaks, have your sprinkler maintenance company repair them immediately to keep the valve from tripping.
- Contact the sprinkler maintenance company immediately if an alarm trips without triggering a full alarm condition. A low pressure trouble signal that clears without much time lapse could actually be the dry system filling with water as a result of a valve failure.
- Inspect the sprinkler system every few hours during periods of extreme cold weather, looking for broken or cracked piping, or other signs of damage.
- Keep an appropriate number of spare sprinkler heads in the main sprinkler control room, along with the necessary tools, in accordance with NFPA 13 standards.
- Display the emergency contact details of your fire sprinkler maintenance provider in the main sprinkler control valve room and at the main fire panel.
- Make sure that the outdoor Fire Department Siamese connections are free of debris and easily accessible. Secure locking caps should be fitted onto any Fire Department Connections that do not already have them.

Should Your Sprinkler System Freeze or Become Damaged

If a sprinkler system malfunctions due to frozen pipes or other damage and it is discharging water, the following steps are critical:

- Shut off the system's Main Control valve to prevent further water damage. It is extremely important that your maintenance staff or other designated persons are trained to perform this procedure.
- Contact your sprinkler maintenance company and local Fire Department immediately.
- Remove affected contents to an unaffected part of the property, if possible, to avoid unnecessary/ further loss. However, do not attempt to enter an area that may be unstable or unsafe.
- If a sprinkler pipe is still frozen, do not attempt to thaw it out by using a heat source or open flame. Contact your sprinkler maintenance company immediately.
- If any pipes have frozen, make sure that the maintenance company examines the entire system for cracked fittings, split pipes, and leaking heads before reconnecting it.
- Report the incident to your insurance broker as soon as possible.

Valve configuration on a Wet Pipe system

Conclusion

The best defense against an automatic fire sprinkler system malfunction is ongoing maintenance, testing and inspection. The level of maintenance and the frequency of testing required are set out by the National Fire Protection Agency.[4] It is important to engage a qualified sprinkler maintenance company — certified by the Underwriters Laboratory of Canada (ULC) — to test and inspect the system in accordance with these regulations. It is also important to ensure that the system in your building has been installed in accordance with the NFPA 13 standard applicable at the time of installation. Your sprinkler maintenance company should advise you as to what measures your maintenance personnel can undertake on their own. At Ecclesiastical, we recognize that even systems that have been regularly maintained and tested can fail from time to time. Our risk control specialists are ready to help you take a proactive approach to recognizing the potential problems and managing the risks.

References

1. Under Canada's Constitution Act, regulation of fire safety is the responsibility of provincial and territorial governments. The National Fire Code (NFC) is in the form of a model code to permit adoption by the appropriate authority. Most provinces and territories adopt or adapt the model NFC and enforce its requirements. http://www. fedpubs.com/subject/construction/natfire.htm

2. National Fire Protection Association, NFPA 13 — Standard for the Installation of Sprinkler Systems http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=13

3. Canadian Conservation Institute: http://www.cci-icc.gc.ca/crc/notes/html/2-8-eng.aspx

4. National fire Protection Association, NFPA 25 — Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

ABOUT ECCLESIASTICAL INSURANCE

Ecclesiastical Insurance Office plc is a specialist commercial insurance company. We are deeply committed to protecting the needs of organizations that enrich the lives of others; to preserving Canada's distinct communities, cultures and history; and to supporting initiatives that help improve the lives of people in need.

ecclesiastical

ecclesiastical.ca | @EIOCanada